Software Process Improvement Handbook

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1   Introduction

1.1   Purpose

This handbook is intended as an introduction to continuous software process improvement (SPI) programs with emphasis on the software process assessment (SPA). It may be helpful to anyone involved in starting up a software process improvement program at an organization. Sections 2 and 3 provide an overview of SPI programs and how they can fit into the organizational framework. Section 4 provides detailed descriptions of all the SPA events. Section 5 catalogs the human resources required of a SPI program including guidelines for selecting SPI personnel.

1.2   Scope

There is no attempt to make this handbook a comprehensive treatise which will answer all possible questions on software process improvement. Nor is this intended as a complete do-it-yourself guide to software process improvement, but it describes the components of a software process improvement program and how they fit together. It also contains guidelines for selecting the appropriate personnel for the program and for coordinating software process assessments. Further details on software process improvements and assessments can be found in the references.

1.3   References

1.3.1   Humphrey, Watts, "Managing the Software Process", Addison-Wesley, 1989

1.3.2   Paulk, Mark C., et al, Capability Maturity Model for Software, Version 1.1, February 1993, Software Engineering Institute, Carnegie Mellon University, CMU/SEI-93-TR-24

1.3.3   Fowler, Priscilla, and Stan Rifkin, Software Engineering Process Group Guide, September 1990, Software Engineering Institute, Carnegie Mellon University, CMU/SEI-90-TR-24

2   Overview of Software Process Improvement.

2.1   Software Process

A software process is any set of consecutive tasks performed during the production of software. A process usually involves software practitioners and/or their managers and may involve software tools. It includes life cycle processes such as requirements definition, design, coding, writing test plans, testing, releasing the software, and maintenance, as well as such processes as software configuration management, software quality assurance, and project management, which cover more than one stage of the life cycle. Most processes can be broken down into subprocesses, or they can all be thought of as subprocesses of the organization's all-inclusive software process, as in the title to reference 1.3.1.

The Software Engineering Institute at Carnegie-Mellon University has produced a scheme called the Capability Maturity Model for classifying software producing organizations according to the maturity of their software processes. This model is documented in reference 1.3.2. The document carefully defines all the major software processes at a high level of abstraction, independent of software domain, tools, or other environmental encumbrances.

2.2   Sponsorship

The most important prerequisite for a successful continuous software process improvement program is sponsorship by senior management committed to process improvement. Without the active backing of management, improvements will be limited to isolated pockets of the organization at best. This handbook assumes that senior management strongly sponsors the process improvement effort; it does not address the process of obtaining management commitment to the program.

2.3   Software Process Improvement

A continuous software process improvement program in an organization is a permanent program to define and improve the software processes used by the organization. Once established, such a program supports a repetitive cycle of software process improvement efforts. The following activities are involved in this cycle:

      a)   Assess the current status of software practices in the organization.

      b)   Formulate an action plan for improvement.

      c)   Implement the action plan.

      d)   Return to the first activity and start the next cycle of improvement.

A complete cycle may take from 18 to 36 months.

In the next sections we examine the above four activities in more detail.

2.3.1   Assessment.

Assess the current status of the software practices in the organization. There are a number of process assessment methods available from commercial vendors, but the DoD has decided that all software process assessments within the DoD Corporate Information Management community will use the method developed by the Software Engineering Institute (SEI) at Carnegie Mellon University. This methodology is a formal process designed not only to obtain the needed data on current software practices within the organization being assessed, but also to produce recommendations for improvement and to generate as much awareness, involvement, and enthusiasm for SPI as possible within the organization.

The assessment is performed by a team of 6-8 experienced software engineers selected from within the organization being assessed. (See also the Guidelines for selecting team members in sections 5.1.2.1 and 5.1.3.1.) The assessment team is trained and coached throughout the assessment by outside experts trained and authorized by the SEI to facilitate software process assessments. The team collects data from several sources:

a)   Project leaders from 4 or 5 representative projects fill out a questionnaire on the processes used by their projects. (See also the Guidelines for selecting projects in section 5.1.5.1.)

b)   The same project leaders are then interviewed in more depth by the team.

c)   Four groups of software engineers from across the entire organization provide their comments in a free form discussion. (See also the Guidelines for selecting Functional Area Representatives in section 6.1.6.1.)

d)   Documents on internal processes may be examined.

After collecting the data the assessment team drafts preliminary findings and submits them for review to the above group of project leaders and software engineers to ensure that the findings accurately represent the concerns of these individuals. The team reports its final findings to upper management. Finally, the team submits a written report of the findings and a set of recommended actions for improvement.

2.3.1.1 Assessment Events.

The entire software process assessment consists of several events spaced out over a period of 4 to 6 months. The events, all of which take place at the assessed organization, are:

a)   Executive Briefing. The senior software managers of the organization are briefed about SPAs and continuous software improvement programs. Middle managers should also be encouraged to attend.

b)   Assessment Team Training. The assessment facilitators train the assessment team in how to carry out their central role in the assessment. They are taught the theoretical framework of the assessment and receive practice in the procedures for determining the findings.

c)   Assessment Participants' Briefing. All the project leaders and software engineers who will participate are briefed in their roles, so they will know what to expect. The project leaders fill out the questionnaire. Then the assessment team analyzes the questionnaire responses and

prepares a script of further questions they will use in the project leader interviews which are held during the Assessment Week.

d)   Assessment Week. This is the heart of the assessment process. The assessment team gathers data from the project leaders and software engineers and presents its findings to management as described above.

e)   Recommendations Briefing. The assessment team presents a briefing on its final written report to the senior management

f)   Action Planning Workshop. This event is not a part of the usual assessment process, but has been added in order to help the organization prepare workable improvement plans.

At this point the assessment team has completed its work, although it is highly desirable for them to remain involved in the ensuing improvement activities, so that the insight into the organizational problems that they have gained from their work during the SPA will not be lost to the organization as a whole. Note: Section 4 contains specific time and resource requirements for each of these events.

2.3.2   Action Planning

Formulate an action plan for improvement. Using the findings and recommendations that issued from the SPA, the organization either creates or modifies its high level strategic plan as well as detailed action plans for specific process improvements.

2.3.3   Implementation.

Implement the action plans. Implementation can take from 1 to 2 years depending upon the scope of the plans and the level of resources applied to the effort.

2.3.4   Reassessment.

The actions taken during implementation may not have become firmly rooted in the organization. It is advisable to perform another assessment not only to see how well the action plans worked, but also to reorient for the next improvement cycle.

3   Organizational Infrastructure

The discussion up to now has assumed that a workable organizational structure is in place for carrying out the process improvement cycle. This section briefly describes such a structure which has been recommended by the SEI. It consists of two permanent groups which, together, are responsible for overseeing and coordinating all software process improvement activities.

3.1   Software Engineering Process Group (SEPG)

The first group, which the SEI calls the Software Engineering Process Group, is in charge of day-to-day direction and coordination of all SPI activities. In particular the SEPG

a)   Provides support for the assessment team during the assessment.

b)   Supervises the creation of improvement action plans.

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c)   Oversees, directs, coordinates, and supports the working groups who implement the tactical action plans.

d)   Arranges for the next process assessment.

Note that the SEPG members do not have time to personally carry out the details of the action plan. This work is done by temporary working groups chosen for their expertise in the various areas undergoing process improvement.

3.2   Executive Steering Committee

The SEPG is part of the overhead structure of the organization, like a personnel office. It does not have direct authority over the process action teams or working groups, whose members are temporarily borrowed, often on a part-time basis, from the software projects. First line managers are often unwilling to release their most experienced employees to work outside the project, even temporarily. Strong incentives from higher management may be needed initially to free up time for key personnel to participate in the working groups.

An Executive Steering Committee, consisting of senior software managers, can provide such direction. In particular the committee:

a)   Sets process improvement goals for the organization

b)   Approves all SPI plans

c)   Prioritizes the improvements to be made

d)   Sets the level of resources to be applied to the plans

e)   Ensures that those resources are made available

f)   Publicly recognizes and rewards high achievers in SPI

The SEPG reports directly to this Executive Steering Committee and works closely with it on all SPI issues.

4   Software Process Assessment Events

This section describes the six events of a software process assessment, their purpose, and some of the logistics required of the assessed organization for carrying them off smoothly. All events take place at the assessed organization, which is responsible for providing appropriate rooms and materials for the events.

4.1   General Considerations

The assessed organization may need to arrange the following items for outside participants (such as the assessment facilitators) at each event:

a)   Building passes (or security clearances)
b)   Parking places
c)   Hotel and restaurant suggestions
d)   Maps

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e)   Point of Contact phone number, email, and mailing address

Management must ensure that all participants of these events are released from other duties while they are participating in the assessment events. The assessment must take precedence except in cases of real emergency.

4.2   Executive Briefing

4.2.1   Participants

The assessment facilitators;
The Senior software manager;
The senior software manager's staff;

Mid-level managers and other interested parties (at the   invitation of the senior manager);
The assessment team (if it has been selected);
The SEPG.

4.2.2   Purpose

The assessment facilitators brief the senior software manager and the other participants about continuous software process improvement programs and software process assessments. The meeting is designed to be both informational and inspirational: to clarify software process improvement concepts and to elicit enthusiasm and buy-in by the participants.

4.2.3   Duration

About two and a half hours.

4.2.4   Logistics

The briefing requires:

a) A room large enough to hold all the participants comfortably

b) At least one and preferably two overhead projectors and screens

c) A VCR and monitor (if a videotape is shown)

4.3   Assessment Team Training

4.3.1   Participants

a)   The assessment facilitators
b)   The assessment team
c)   CIM staff members
d)   A limited number of other interested individuals

Note: SEI-approved training materials are purchased in blocks of ten. If there are to be more than ten in the class, the facilitators must know in advance to order two sets of training materials. Twenty students is a maximum class size.

4.3.2 Purpose

The assessment facilitators train the assessment team in how to carry out their central role in the assessment.   The students are taught the theoretical framework of the assessment and receive practice in the procedures for determining the findings. Team building is an important part of this event.

4.3.3 Duration

Three days.

4.3.4 Logistics

The training requires:

a)   A room large enough to hold all the participants comfortably

b)   One or two break-out areas

c)   An overhead projector and screen

d)   A VCR and monitor (if the videotape is shown)

e)   Flip charts, markers, and masking tape

f)   CDA mission briefing

4.4   Assessment Participants' Briefing and Response Analysis

4.4.1 Participants

a)   Assessment facilitators
b)   Assessment team
c)   Project leaders of the selected projects
d)   Functional area representatives
e)   Managers of the above participants (optional)

4.4.2 Purpose

This two-day event can be divided into three parts. First, all the project leaders and software engineers who will participate in the assessment are briefed in their roles, so they will know what to expect. After the one-hour briefing, the selected project leaders stay behind to fill out the assessment questionnaire. Then the assessment team analyzes the questionnaire responses and prepares a script of further questions, which they will use in the project leader interviews to be held during the Assessment Week.

4.4.3 Duration

a)   For the assessment team - two days
b)   For the project leaders - two hours
c)   For everyone else - one hour

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4.4.4 Logistics

The following items are needed:

      a)   A room large enough to hold all the participants equipped with:

            * An overhead projector and screen

      b)   A second room for the assessment team and facilitators to use during the response analysis equipped with:

            * An overhead projector and screen

            * Flip charts, markers, and masking tape

            * A PC compatible computer and printer, if possible

4.5 Assessment Week (On-Site Period)

4.5.1 Participants

      a)   The senior software manager
      b)   Assessment facilitators
      c)   Assessment team
      d)   Project leaders of the selected projects
      e)   Functional area representatives
      f)   The SEPG
      g)   Other interested parties at the invitation of the senior manager

4.5.2 Purpose

The assessment week is the heart of the assessment process. The assessment team gathers data from the project leaders and software engineers, analyzes the data, and presents its findings in a briefing to senior management.

4.5.3 Duration

      Five days.

4.5.4 Logistics

The following items are needed:

      a)   A room large enough to hold all the SPA participants equipped with:

            * An overhead projector and screen.

            This room will be needed for the kickoff meeting on Monday morning and for the final findings briefing on Friday morning. Each is about one hour in length.

b) A second room, the "Team Room," for the assessment team and facilitators to use for the entire week equipped with:

  * A conference table large enough for the team to use in working meetings

  * An overhead projector and screen

  * Flip charts, markers, and masking tape, three-hole punch, paper, pens, pencils, stapler

  * A PC equipped with WordPerfect and Harvard Graphics or similar software for word processing and slide production is highly desirable

  * A lock to preserve confidentiality of working papers when the team is not in the room.

c) A room which can be used Tuesday for the four FAR discussion sessions. Ideally, the FARs and the team (about 20 in all) will be seated in a large circle. The team room can be used if it is large enough. No table or other equipment is needed, just chairs.

d) A room large enough to hold the team and all the FARs (about 40-50 in all) for the FAR feedback session on Thursday, equipped with:

  * An overhead projector and screen

e) Administrative support for photocopying, word processing, and producing overhead slides. Some of this will be needed after hours.

f) Coffee, snacks, and some meals must be catered. (Participants pay for this service.)

4.6 Recommendations Briefing

4.6.1 Participants

a) The Senior software manager
b) The senior software manager's staff
c) Mid-level managers and other interested parties (at the invitation of the senior manager)
d) Assessment facilitators
e) Assessment team
f) Project leaders
g) FARs
h) The SEPG

4.6.2 Purpose

The assessment team leader briefs senior management on the final written report of its findings including recommendations for process improvement actions. All assessment participants and interested parties should be invited to this presentation.

4.6.3 Duration

One hour.

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4.6.4 Logistics

The briefing requires:

      a)   A room large enough to hold all the participants comfortably

      b)   An overhead projector and screen

4.7 Action Planning Workshop

4.7.1 Participants

      a)   The Software Engineering Process Group
      b)   The Executive Steering Committee
      c)   Assessment facilitators
      d)   Other personnel involved in action plan development

4.7.2 Purpose

This event is not a part of the usual assessment process, but has been added in order to help the organization prepare workable improvement plans. The workshop will cover both strategic and tactically planning for process improvement.

4.7.3 Duration

      One day.

4.7.4 Logistics

The workshop requires:

      a)   A room large enough to hold all the participants comfortably

      b)   An overhead projector and screen

      c)   Flip charts, markers, and masking tape

5 Human Resources

This section outlines the amount and nature of the human resources required to maintain a successful software improvement program.

5.1 SPA Resources

The SPA involves the following individuals and groups:

      a)   Senior management
      b)   Assessment Team Leader
      c)   Assessment Team Members

d)   Site Coordinator
e)   Project Leaders
f)   Functional Area Representatives
g)   Assessment Coaches

Each of these groups will be considered separately in the following paragraphs.

5.1.1   Senior Management

5.1.1.1 Personnel Characteristics

The senior software manager is the lowest level software manager who has responsibility for that part of the organization being assessed. The term senior management here includes the senior software manager, those software managers who report directly to the senior software manager, and any other lower level or higher level managers that the senior software manager wishes to invite to the SPA.

5.1.1.2 Dedicated SPA Time

Senior management must be committed to attend the following meetings:

Executive Briefing			3	hours
Assessment Participants Briefing	1	hour		
Kickoff Briefing	1	hour		
Findings Briefing			1	hour
Findings Executive Session (optional)	1	hour		
Recommendations Briefing			1	hour

Total			8	hours

5.1.2   Assessment Team Member

5.1.2.1 Selection Guidelines

A team member should have a strong software engineering background (10 years or more).

Avoid putting managers and supervisors on the team. The team will be interviewing project leaders and functional area representatives, who must feel free to say whatever is on their minds. Managers on the team may inhibit this freedom of expression.

The team must work together to come to consensus on many issues. Avoid people who would not actively participate, as well as those who would try to dominate or not cooperate.

Team members should be volunteers, not unwilling draftees. It is difficult to become an effective team member, if you don't want to be there at all.

If nepotism exists within the organization, it should be considered in selecting team members in order to avoid the appearance of a compromise in confidentiality.

Some or all of the team members should transition into the Software Engineering Project Group (SEPG) to guide the action planning and implementation stages of the improvement. This further commitment of their time should be taken into account.

5.1.2.2 Dedicated SPA Time

Each assessment team member must be committed to spend the following amounts of time during the SPA:

Assessment Team Training		3	days
Assessment Participants Briefing	2	days	
Assessment Week		5	days
Write final report fragment		4	days
Final report review		2	days
Preparation Time for events		7	days

Total		23	days

5.1.3 Assessment Team Leader (ATL)

5.1.3.1 Qualifications

The assessment team leader is the leader of the assessment team and is a full participating member of the team. The ATL is the team's representative to the organization and, in particular, presents the Assessment Participant's Briefing, the Kickoff Briefing, the Findings Briefing, and the Recommendations Briefing.

The ATL must, therefore, satisfy all the qualifications of an assessment team member and, in addition, must be experienced at giving presentations. It is, furthermore, desirable that the ATL be known and trusted by management so that senior management will accept the validity of the findings, however negative or unwelcome they may be. If the ATL is not appointed by senior management, then the team will elect one of its own members as the ATL.

5.1.3.2 Dedicated SPA Time

The ATL must be committed to spend the following amounts of time during the SPA:

Assessment Team Training		3	days
Assessment Participants Briefing	2	days	
Assessment Week		5	days
Write final report fragment		4	days
Final report review		2	days
Preparation time for events		10	days

Total		26	days

5.1.4 Assessment Coordinator (Site Coordinator)

5.1.4.1 Duties and Selection Guidelines

Assessment coordination is a support function and does not require a knowledge of software engineering.

The assessment coordinator arranges the following logistics of all the SPA team events.

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a)   Reserve conference rooms

b)   Provide materials:
                Overhead projectors
                Flip charts, markers, masking tape
                White boards, erasers, markers
                Blank transparencies, markers
                Paper, pencils, erasers, pens

c)   Schedule assessment participation for:
                Senior management
                Project leaders
                Functional area representatives
                Assessment team members

d)   Arrange secretarial support
                Regular time / After hours

e)   Arrange photocopy facilities
                Regular time / After hours

f)   Arrange for slide production
                Regular time / After hours

g)   Arrange meals, coffee, and snacks
                Regular time / After hours

h)   Arrange hotel accommodations, maps, identification badges, security clearances, parking for
         out-of-town participants

i)   Coordinate with assessment team and coaches

5.1.4.2 Dedicated SPA Time

The assessment coordinator must be committed to spend the following amounts of time during the SPA:

Team Training (on call)	3	days
Participants Briefing (on call)	2	days
Assessment Week	5	days
Preparation time	15	days

Total	25	days

The assessment coordinator must be always on call during the team events to support the needs of the team. During assessment week this might mean working after hours.

5.1.5   Project Leader

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A project leader is a software manager with responsibility and authority over a software engineering project. Depending upon the organization's structure, this may or may not be a first-line manager. The project leader should usually be the person most able to answer the assessment team's questions about the software processes being used by the project.

Once a project has been chosen for the assessment, the identity of the project leader is usually obvious.

5.1.5.1 Project Selection Guidelines

Choose 4 or 5 representative projects. Projects should be "typical" of the organization. Consider such factors as:

    a)   Size of project
    b)   Language
    c)   Application domain
    d)   Life cycle phase
    e)   Age
    f)   Environment
    g)   Technology

Select a mix of development/maintenance phases and project durations.

Projects should have a life cycle span of at least 6 months.

Projects should have a staff of at least 4 people.

Include research, development, maintenance and other projects as appropriate to get a good representation of the organization.

Make sure that project leaders and other management in the chain of command all agree to allow the project to participate.

Ensure that there is no conflict between SPA dates and critical project activities.

Projects should not be in the competitive phase of a procurement process.

5.1.5.2 Dedicated SPA Time

Each project leader must be committed to spend the following amounts of time during the SPA:

Assessment Participants Briefing	2	hours
Assessment Week	5	hours
Recommendations Briefing	1	hour

Total	8	hours

5.1.6   Functional Area Representative (FAR)

The SEI recommends that 4 functional area sessions be conducted during the on-site period, one in each of the following functional areas:

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a)   Quality assurance and release
b)   Software integration and test
c)   Code and unit test
d)   Requirements and design

Choose 8 to 10 different individuals from across the assessed organization for each functional area discussion. Some of the FARs, but not all of them, should come from the selected projects. The FARs should represent a cross section of the entire assessed organization.

5.1.6.1 Qualifications

A FAR should be expert in the functional area.

A FAR should be an opinion leader.

A FAR should be a practitioner rather than staff or management.

FARs should not all come from the representative projects.

FARs must have buy-in from their managers.

Choose people who will not inhibit the free flow of information, but are not too shy or reticent to speak out.

5.1.6.2 Dedicated SPA Time

Each Functional Area Representative must be committed to spend the following amounts of time during the SPA:

Assessment Participants Briefing	1	hour
Assessment Week	5	hours
Recommendations Briefing	1	hour

Total	7	hours

5.1.7 Assessment Coaches

The assessment team will be coached by one or more assessment coaches from the SEI or one of its licensed vendors. It is their responsibility to assure that the assessment is done in accordance with the SEI methodology.

5.1.8 SPA Resource summary

The following is a rough estimate of the resources needed over a 4-6 month period to perform a software process assessment.

Assessment team members (5-7)	184 hours each
Assessment team leader (1)	208 hours
Site coordinator (1)	200 hours
Senior managers	8 hours each
Project leaders (4-6)	8 hours each
Software professionals (32-40)	6 hours each

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5.2   Software Engineering Process Group (SEPG)

The SEPG positions should be dedicated to full time work on software process improvement. However, it is desirable to rotate personnel in and out of the SEPG for the following reasons:

>   a)   Rotation gives many employees a chance to learn from the SEPG experience;

>   b)   Rotation provides fresh ideas and viewpoints to the SEPG;

>   c)   An SEPG member who coordinated part of a process improvement action plan should not be involved in the following SPA, which evaluates the success of that plan.

5.2.1   SEPG Human Resource Requirements

The SEI recommends that the SEPG be staffed at 1% to 3% of the total number of software engineers and managers in the assessed organization. Another 1% to 3% of the staff will be needed for software process improvement activities throughout the improvement cycle.

5.2.2   Guidelines for Selecting SEPG Members

An SEPG member should have the following characteristics:

>   a)   Strong software engineering background

>   b)   Ability to organize and direct working groups

>   c)   Communications skills

>   d)   Ability to elicit cooperation and enthusiasm

Some SEPG members should transition from the Assessment Team to provide continuity from the assessment to the action planning and implementation stages.

An SEPG member should not be new to the organization.

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